Penetrating abdomino-thoracic injuries: report of four impressive, spectacular and representative cases as well as their challenging surgical management

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Gunshot wounds are rare events in European countries, but stab and impalement injuries occur more frequently and are often spectacular.

The aim of the study was to describe several types of penetrating abdomino-thoracic injuries as well as the appropriate surgical interventions, including complex wound management.

Material and methods. The representative case series includes four patients with abdomino-thoracic penetrating trauma (two impalements and two stabings), who were treated in a surgical university hospital (tertiary) centre during a 12-month period.

Results. 1. A man was impaled on a steel pipe, which entered the body above the right kidney and behind the liver through the mediastinum via the right thorax, passing the heart and aortic arch up to the left clavicle. The rod was removed via sternotomy and median laparotomy. Only the left subclavian vein required repair. Postoperatively, a residual lesion of the left brachial plexus caused temporary pneumonia. 2. A leg of a collapsing chair drilled into a woman’s left foramen obturatorium and exited the body at the right anterior iliac spine. At a regional hospital, the chair leg was removed and the canal caused by gluteal penetration was excised. Exploratory laparotomy revealed peritonitis resulting from a perforated ileum. The injury was repaired with segmental resection and anastomosis. Postoperative right inguinal wound necrosis necessitated excision and vacuum-assisted closure sealing. The patient has residual paresthesia in her left leg resulting from a sacral plexus lesion. 3. During an altercation, a man was stabbed twice in the right thorax. The right pulmonary lobe, the diaphragm, and the liver dome between segment VIII and V were injured. The patient also had a large scalp avulsion at the left and right parietooccipital site and transection of the biceps muscle at the middle third of the right humerus. The chest injuries, approached via right subcostal incision and right anterior thoracotomy were managed with liver packing (two towels, removed after 2 days), suture of the diaphragm, and pleural drainage. 4. A man was stabbed in the left thorax, resulting in pneumothorax and lesions of the diaphragm and left third of the transversal colon, and the neck, resulting in lesions of the pharynx and internal jugular vein. These injuries were approached with left thoracic drainage and suture of the colon and diaphragm lesions. Subsequent right thoracotomy was required to treat right pleural empyema caused by bronchopneumonia as a consequence of blunt thoracic trauma. In addition, the patient required relaparotomy to drain an abscess within the Douglas space and Billroth II gastric resection to control recurrent Forrest-Ia bleeding.

# The authors are equally involved in creating manuscript idea, writing, proof-reading and overall management of the manuscript; therefore, both of them should be considered first authors.
Conclusions. Penetrating abdomino-thoracic injuries demand immediate life-saving measures, transfer to a trauma centre, appropriate resuscitative care, prompt diagnosis, and surgical intervention by an interdisciplinary team of abdominal, vascular, and cardiac surgeons. If these measures are provided, outcomes are maximized, mortality is minimized, and permanent damage can be avoided. **Key words:** penetrating injuries, thorax / chest, abdomen, impalement injury, stab wound

Impalement and stab injuries are occasionally a subject of case reports in the medical literature (1-4), particularly those with spectacular combinations of cause, injuries, and outcome. Impalement injuries often result from falls from a height onto a sharp object. Abdomino-thoracic stab injuries are nearly always the result of violent conflicts. Gunshot wounds are rare in European countries; therefore, we did not include such cases in this series.

Control of blood loss and stabilization of vital organ function have absolute priority over all other diagnostics and therapeutic measures in the management of penetrating injuries (3). Immediate control and stabilization of vital functions should be established at the site of the incident. The penetrating object should be left *in situ*. After the patient has been transferred to a hospital, urgent therapeutic measures and diagnostics must be undertaken simultaneously. A surgical approach provides an adequate overview. The goals of surgical intervention are primary bleeding control and hemostasis; further stabilization of vital functions; as well as operative repair of lung, heart, parenchymatous, hollow organ, and concomitant injuries, as required (5).

We describe four impressive, spectacular and representative patients with penetrating abdominothoracic trauma two complex impalements and two stab wounds who were treated at a tertiary surgical centre.

**MATERIAL AND METHODS**

1. While trimming a fruit tree, a 64-year-old man fell from a height of 2 meters into a currant shrub. The shrub was supported by a steel pipe, 18 mm in diameter. The pipe entered the man’s body at the right flank and exited through the left thorax near the middle third of the left clavicle. The man clung to the pipe and was fully conscious. The fire fighters who responded to the incident immediately cut off the pipe. An emergency physician instituted emergency care at the scene. Upon arrival at our hospital, the patient’s vital signs were stable. A plain film of the thorax (fig. 1), an abdominal ultrasound, and a multi-slice computed tomography (CT) scan of the thorax and abdomen were obtained prior to surgical intervention. Imaging diagnostics showed that the steel pipe entered the body above the right kidney and behind the liver. It entered the mediastinum via the right thorax, passed the heart and the aortic arch, and stopped at the left clavicle (fig. 2).

![Fig. 1. Chest film (posterior/anterior) of the thorax. Metal rod detectable in situ (patient 1)](image1)

![Fig. 2. Metal rod at the time of admittance to the hospital (patient 1)](image2)
A team of abdominal, vascular, and heart surgeons approached the thorax via sternotomy and the abdomen via median laparotomy. Perioperative prophylactic antibiotics were administered. The pleural cavities were found to be filled with 200 mL of blood. In the abdominal cavity, the pipe laid in front of the right kidney and behind the liver; no parenchymatous injuries were noted. Surprisingly, neither the aortic arch nor the left subclavian artery at its branching off point from the aortic arch was injured. The pipe was shortened above the left clavicle and then carefully pulled back into the left pleural cavity. Bleeding occurred only from the left subclavian vein. While ventrally retracting the aortic arch, the team extracted the pipe into the mediastinum. No severe arterial, venous, or cardiac lesions were seen. After ventral mobilization of the right pulmonary hilus, the steel rod was pulled retrotracheally into the right pleural cavity without provoking severe bleeding. Leakage at the bronchi and trachea was excluded by intraoperative bronchoscopy. Subsequent esophagastroscopeopy also revealed no lesion. The rod was pulled backward via the right phrenicocostal recess into the abdominal cavity and finally completely removed. No hepatic or renal injuries were found. The left subclavian vein was sutured and the operative sites were lavaged. Bilateral pleural drains and an abdominal drain were placed and the surgical wounds were closed. Postoperatively, the patient was transferred to the surgical intensive care unit (ICU). A fracture of the left clavicle showed no dislocation and healed with conservative treatment. A lesion of the left brachial plexus, causing symptoms in the left arm and shoulder, was treated with physiotherapy. Postoperatively, residual damage of the left suprascapular nerve caused sensory and motion dysfunction of the shoulder joint. Postoperative right pneumonia developed and was treated successfully with antibiotics and respiratory therapy. The patient’s convalescence was otherwise uneventful, and he was discharged after 4 weeks.

2. While working at a chicken farm, a 54-year-old woman fell off a chair. One leg of the chair drilled into her left “foramen obturatorium” and left the body at the right anterior iliac spine (fig. 3). A 30-cm section of the chair leg was removed in a regional hospital and the canal caused by gluteal penetration was excised. Because of developing abdominal signs and symptoms, including free fluid, the patient was transferred to our hospital on the following day. Laparotomy revealed a perforated ileum approximately 50 cm from Bauhin’s valve (fig. 4), which was treated with ileum segment resection and extensive lavage because of fibrinous peritonitis. Postoperative care in the ICU, including broad-spectrum antibiotic treatment, quickly stabilized the patient. However, right inguinal wound necrosis developed during the postoperative course, necessitating excision. A vacuum-assisted closure sealing was left in place for 20 days. Concomitant in-
jury of the sacral plexus caused residual paraesthesia in the patient's left leg.

3. During a violent conflict, a 67-year-old man received several stab wounds. Two stabs entered the right thorax and another injured the right lobe of the lung, the diaphragm, and the liver. The patient also had a large scalp avulsion at the left and right parieto-occipital sites and transection of the biceps muscle at the middle third of the right humerus. After initial diagnostics, including detection of acute posthemorrhagic anemia, in a regional hospital, the patient was transferred to our clinic. An immediate right subcostal incision and right anterior thoracotomy revealed a stab canal extending from the right lateral thoracic wall through the right lobe of the lung and the diaphragm and into the liver dome between segments VIII and V (fig. 5). A second stab had penetrated the thoracic wall. Surgical intervention included liver packing with two towels, suturing of the lung injuries and of the diaphragm, and placement of two pleural drains. The remaining lesions were sutured during the same operative procedure after further stabilization of vital functions. The patient required a total of nine units of packed red cells. After 72 hours, the patient underwent relaparotomy to remove the towels. The hepatic lesion had completely suspended. The subsequent postoperative course was uneventful.

4. A 22-year-old man was injured in the left thorax and neck during a violent conflict in which he was stabbed several times with a knife. He sustained a pneumothorax and lesions of the left diaphragm as well as of the left third of the transverse colon. A neck injury involved lesions of the pharynx and the internal jugular vein (fig. 6). In addition, the patient sustained blunt right thoracic trauma when he jumped from a balcony (a height of 2 m). After being transferred to our emergency service, the patient was intubated and had stable cardiovascular functions. A left thoracic drain was placed. Perioperative prophylactic antibiotics were administered, the colon and diaphragm lesions were sutured shut, and extensive lavage was performed.

On the 14th postoperative day, the patient underwent right thoracotomy because of a right pleural empyema causing bronchopneumonia as a consequence of the blunt right thoracic trauma and relaparotomy because of an abscess within the Douglas space. The postoperative course was further complicated. During treatment in the surgical ICU, recurrent Forrest-Ia bleedings were caused by a duodenal ulcer. The initial bleeding episodes had been stopped with interventional endoscopy, but they ultimately required surgical intervention comprising transduodenal purse-string sutures and gastric resection according to the Billroth II procedure. The patient’s recovery was prolonged, but he was finally transferred in stable condition to a rehabilitation center.

**DISCUSSION**

The spectrum of penetrating abdomino-thoracic injuries ranges from small, slight trauma to severe, life-threatening injuries. The severity of organ injuries and the extent of blood loss determine the mortality risk. One important factor is the institution of competent and im-
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mediate emergency care, which includes resuscitation of the patient with shock therapy, as appropriate, and stabilization of vital cardiorespiratory functions according to the "ABC" rules. The mechanism and the severity of the trauma need to be evaluated immediately in order to define the adequate first aid measures.

For penetrating trauma, it is important to initially leave the object in the body and thus to avoid further blood loss. In many cases, intestinal and pulmonary leakage can be controlled by compression with a wound dressing tamponade. For restoration or stabilization of respiratory function, early intubation is frequently indicated. Signs and symptoms of a hemo- and/or pneumothorax indicate the need for placement of a thoracic drain. For stab wounds, blood loss can be stopped by compressing wound dressings; concomitant thoracic drainage is indicated. After stabilization of vital functions, the patient must be transferred as quickly as possible to a competent trauma centre. Untoward delay in the initiation of definitive treatment of a patient with obvious thoracic injury and continuing blood loss prior to transfer to a surgical centre (as described in case 3) must be avoided.

Upon arrival at the hospital, stabilizing measures should be continued while the quickest possible and most effective diagnostics are initiated. Simultaneously, the necessary lifesaving emergency procedures should be initiated, e.g., blood transfusion, infusion of crystalloid and colloidal solutions, cardiovascular monitoring should be established, and life-threatening injuries should be found out and immediately approached if necessary as well as finally evaluated and documented (6). To assess the complexity of trauma-induced injuries, a computed tomography (CT) scan should be performed in addition to common emergency diagnostics (X-ray films of the thorax, abdominal ultrasound), as deemed necessary by the patient’s condition. Novel techniques such as the multi-slice CT scan allow fast acquisition of high-resolution 3D images, prerequisite for 3D visualization, which are useful for planning the surgical intervention.

An adequate surgical approach is essential for the assessment and treatment of most penetrating injuries, often involving an interdisciplinary team of specialists (as was called together for the management of patient 1) (7). After the impaling object has been removed, organ injuries, particularly cardiac and vascular injuries, need to be approached, in order of their severity. Severe lesions of central vessels can lead to peripheral ischemia (8). After vascular injuries are addressed, parenchymatous injuries and lesions of hollow organs should be approached. The possibility of this type of lesion should always be considered. Removal of an impaling object should be followed by laparotomy, as was done in the management of our patient 2. The consequence of not performing laparotomy could be peritonitis with all of its disadvantageous concomitants. Primary repair of organ injuries is usually worthwhile, but it should not be forced. Drainage of the injured regions and perioperative and postoperative prophylaxis against infection with broad-spectrum antibiotics are very important after a microbiological smear has been obtained and the penetration and operation sites have been rinsed extensively (9, 10). In addition to the factors mentioned above, the patient’s prognosis depends on prevention of subsequent severe infections at the sites of former surgical interventions (patient 4).

CONCLUSIONS

The representative cases presented in this article demonstrate the spectrum of complex or combined penetrating injuries treated in a surgical centre. These types of injuries typically require simultaneous as well as subsequent surgical interventions to repair vessels, organs, and soft tissue. They indicate the importance of an immediate and correct diagnosis and of the immediate initiation of adequate surgical intervention in order to prevent fatal outcome, ensure maximal organ function, and minimize permanent damage.

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